ACCUMULATION RATE AND CHARACTERISTICS OF SEPTIC TANK SLUDGE AND SEPTAGE

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ACCUMULATION RATE AND CHARACTERISTICS

OF SEPTIC TANK SLUDGE AND SEPTAGE

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PREFACE

In Ontario approximately 500,000 septic tank-leaching bed systems are in continuous use for household sewage disposal in rural areas. An additional 165,000 are used to service summer cottages.

The removal and subsequent safe disposal of accumulated solids from these systems is necessary to provide both trouble free operation of the systems and effective waste treatment.

This report characterizes septic tank solids, both quantity and quality, to facilitate the planning and design of septage disposal methods.

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TABLE OF CONTENTS

	Page
Preface	I
Table of Contents	II
List of Tables	III
Summary	IV
1. Introduction	1
2. Materials and Methods	2
3. Results and Discussion	6
3.1 Accumulation Rate of Sludge and Septage	6
3.2 Time Intervals Between Septic Tank Cleanings	8
3.3 Determination of Contaminant Concentration in Septage	9
3.4 Chemical and Bacteriological Characteristics of Sludge and Septage	11
3.5 Balans of Salt in the Septic Tank Contents	16
3.6 Inorganic and Organic Content of Sludge	16
4. Conclusions	18
5. Acknowledgement	19
References	20

LIST OF TABLES

		Page
Table 1	Septic Tank Capacities and Accumulation Rate of Sludge	3
Table 2	Expected Time Intervals Between Septic Tank Cleanings	10
Table 3	Concentration of Contaminants in Septic Tank Supernatant	12
Table 4	Concentration of Contaminants in Septic Tank Sludge	13
Table 5	Concentration of Contaminants in Septic Tank Septage	14
Table 6	Some Inorganic Constituents in Septic Tank Sludge	17
Table 7	Amount of COD and TOC Per Dry Unit Weight of Sludge	17
Table 8	Concentration of Some Contaminants in Domestic Septage as Compared with Literature Date	18

ACCUMULATION RATE AND CHARACTERISTICS OF SEPTIC TANK SLUDGE AND SEPTAGE

SUMMARY

The disposal or treatment of septic tank pump out, a mixture of sludge and supernatant known as septage, is an important part of septic tank maintenance practice.

Three septic tanks of different capacities used for treatment of domestic sewage of different strength were investigated for a period of about two years. The experimental data obtained show the effect of the strength of the sewage and the effect of the detention time in the septic tank on the accumulation rate and on the chemical and bacteriological properties of the sludge and septage.

It was observed that longer detention times contribute to better decomposition of the organic matter of the sewage and consequently to smaller accumulation rates of the sludge in the septic tank.

A simple sampler for taking sludge and supernatant samples and for measuring the depth of the sewage fractions in the tank is also described.

ACCUMULATION RATE AND CHARACTERISTICS OF SEPTIC TANK SLUDGE AND SEPTAGE

1. Introduction

Approximately 2.5 million residents of Ontario live in areas located beyond reach of public sewers, using mainly conventional subsurface sewage disposal systems (septic tank - leaching bed) for domestic wastewater treatment. Proper and long lasting operation of such systems requires regular cleaning of the septic tanks each time the sludge in the septic tank reaches a "dangerous level" i.e. when the sludge is close to overflow into the leaching bed and consequently could cause clogging of the soil and deterioration of the disposal system. The existing Canadian and USA septic tank regulations (1,2) specify a minimum permissible distance between the surface of the sludge and the outlet fitting of the tank[1)].

The disposal or treatment of the septic tank "pump-out" after cleaning the tank, a mixture of sludge and supernatant usually known as septage, is an important part of septic tank maintenance practice and thus experimental data on the sludge accumulation rate and time intervals between septic tank cleanings as well as data on the sludge and septage characteristics are of practical significance for environmental officials, consulting engineers, operators of disposal facilities and septage pumpers. There has been little information available on the nature of the septic tank sludge and septage.

The purpose of this study was to examine the effect of the septic tank capacity and of the strength of the sewage treated in the tank on the accumulation rate and on the chemical and bacteriological characteristics of the sludge and septage. The intent of this study was also to determine

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1) According to the Ontario Septic tank recommendations, the permissible highest level of the sludge in the septic tank is 0.46 m (18") below the bottom of the outlet fitting. (1)

the volume of septage generated per year in Ontario and to determine the land area required for the septage disposal.

2. Materials and Methods

Three concrete, two-compartment, septic tanks were under study for a period of about two years. The septic tanks, all of which were of continuous, year-round use, are located in Southern Ontario. The exact location of the septic tanks, the tank capacities as well as the kind of wastewater treated and the number of people using the disposal systems are given in Table 1.

Table 1 contains also some determined technical data, following from the septic tank operation process, such as the sludge accumulation rate in each of the tank compartments, the maximum permissible volumes of sludge calculated in accordance with the Ontario septic tank regulations and the required time intervals between septic tank cleanings.

The septic tanks, at the Hawkestone farm and at the Orillia Hospital house, were located near the houses and connected to the house wastewater piping systems by short, tight pipes enabling only the house wastewater to enter the septic tanks. However, the Whitby station septic tank was connected to the six houses serviced, by about a 300 meter long sewer pipe, having six manholes along one of the Whitby streets. Some amount of run-off water entered the pipe diluting to some extent the wastewater in the septic tank. Grit and silt could also enter the Whitby tank, at the same time, affecting the sludge accumulation rate.

Sludge and supernatant samples were taken from both septic tank compartments by using a special designed sampler which was also used for measuring the depth of the sludge and of the total liquid in the tanks[1]. (Figure 1).

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1) The sampler was designed and manufactured by Mr. F. Rodrigues of the Applied Sciences Section.

TABLE 1 SEPTIC TANK CAPACITIES AND ACCUMULATION

RATE OF SLUDGE

Location of Septic Tank (ST)		Hawkestone Farm	Orillia Hospital House	Whitby Experimental Station
Kind of Wastewater Treated		Toilet wastewater only	Toilet, Bathroom and Kitchen Wastewater	Toilet, Bathroom, Kitchen, Laundry Wastewater
No. of residents served	persons (p)	3	11	28
Amount of wastewater treated in ST	litres/day l/p.d.	352.8 117.6	1951.4 177.4	4704.0 168.0
Depth of liquid in ST	meters (m)	1.20	1.30	1.22
Volume of Septic Tank	I compartm. l. II compartm. l. Total	2440 970 3410	3055 1535 4590	6340 2640 8980
Detention Time[1]	days (d)	∿9.7	∿2.4	∿1.9
Accumulation rate of the sludge in the Septic Tank	I compartm. l/p.d. II compartm. l/p.d. Total l/p.d.	0.17 0.01 0.18	0.17 0.05 0.22	0.27 0.02 0.29
Volume of sludge accumulated in ST between cleanings[2]	I compartm. l II compartm. l Total l	1504 (61.6%) 89 (9.0%) 1593 (46.7%)	1974 (64.6%) 581 (37.9%) 2555 (55.7%)	3964 (62.5%) 294 (11.1%) 4258 (47.4%)
Permissible time interval between S.T. cleanings	years (y)	8.08	2.89	1.44

1) Detention time = volume of tank in litres divided by daily wastewater discharge in litres per day.

2) The volumes of the sludge accumulated during the time between septic tank cleanings are the volumes at the time when the sludge in the I compartment reaches a maximum permissible level (0.46 m below the level of the liquid). Percentage in brackets shows relation of sludge volume to the total volume of the liquid.

3) Imp. gal. = 4.546 litres.

The sampler consisted of a transparent acrylic graduated cylinder 75 mm ID and 1.8 m in length, equipped with a hinged bottom. After being placed vertically into the septic tank, the cylinder was pressed to the bottom of the tank closing the bottom lid and trapping the sample. Sludge and supernatant samples were taken from the sampler through several drain cocks located at different distances from the bottom.

The heights of the sludge and of the supernatant columns, clearly visible in the transparent graduated cylinder of the sampler, were equal to the depths of the sludge and supernatant in the septic tanks. The volumes of the sludge and supernatant, in both of the compartments of the septic tanks, were calculated from the measured depths of the sewage fractions in the septic tank and from the bottom areas of the septic tank compartments.

The sludge accumulation rate in the septic tank, expressed in litres per person per day (l/p.d.), was determined from the measured sludge volume, from the time intervals between measurements and from the number of residents using the system.

The time when a septic tank had to be pumped out was determined by the level of the sludge in the first compartment because, as was already shown elsewhere(3), the sludge accumulation rate in the first compartment of a septic tank is usually much in excess of the accumulation rate in the second one. The pump-out of the tank took place when the level of the sludge in the first compartments reached a distance of 0.46 m from the level of the liquid in the tank. The volumes of sludge accumulated in the second compartments of the septic tanks, during the time intervals between regular septic tank cleanings (shown in Table 1), were calculated from the determined sludge accumulation rates in those (second) compartments and from the time intervals between septic tank cleanings.

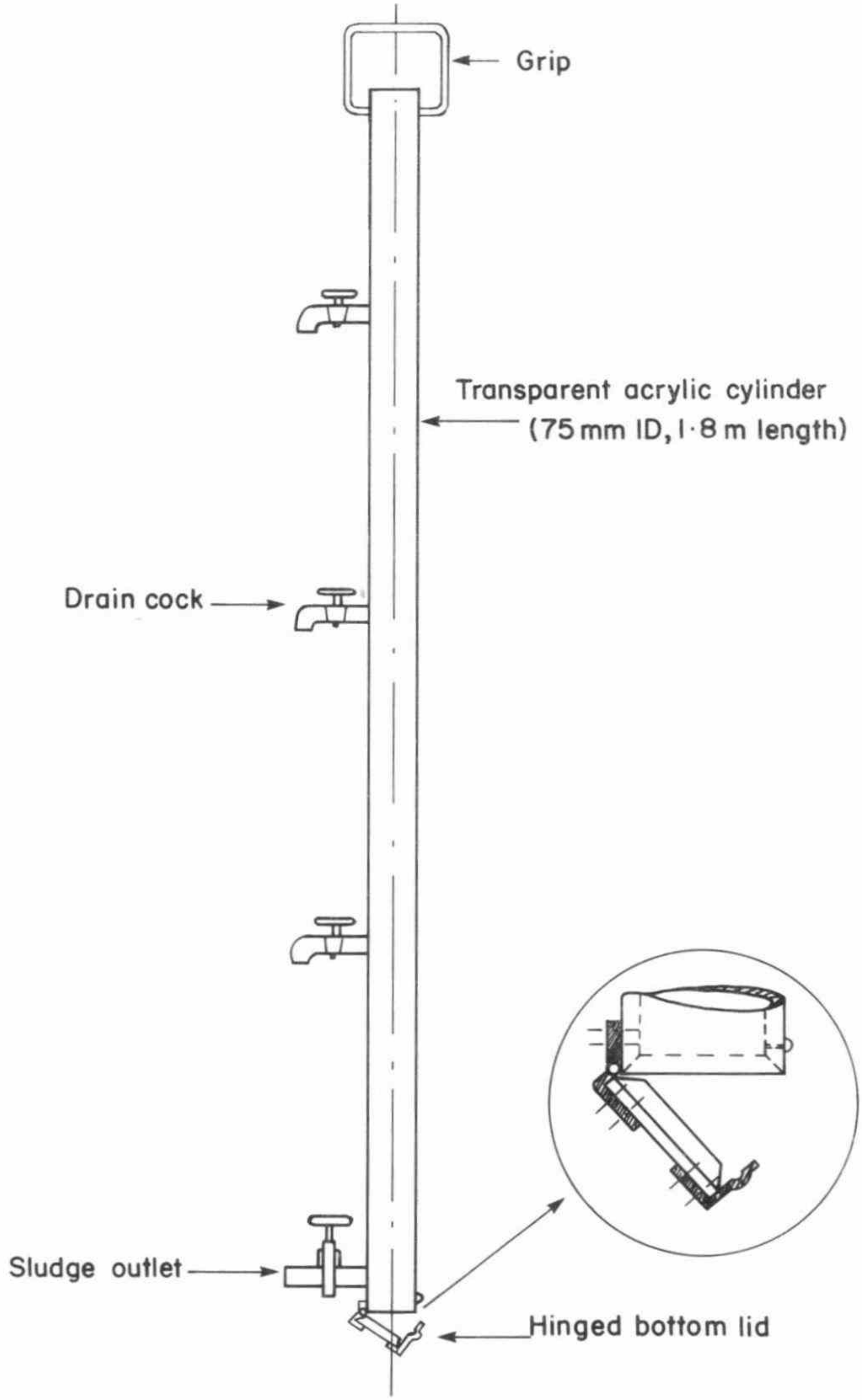

FIG.1 . SEPTIC TANK SLUDGE SAMPLER

Simple calculations based on the sludge accumulation rates and volumes of septic tank compartments given in Table 1 show that the sludge from the first compartment should start to overflow to the second one before the sludge in the second compartment will reach the maximum permissible level allowed by septic tank regulations[1].

The chemical and bacteriological analyses of the supernatant and sludge were conducted in accordance with "Standard Methods"(4).

3. Results and Discussion

3.1 Accumulation Rate of Sludge and Septage

The difference in the strength of the raw sewage entering the septic tanks as well as the different detention times during which the sewage was treated in the tanks brought about considerable differences in the accumulation rates of the sludge and septage (Table 1). The strength of the raw sewage was not tested.

The detention time, which is determined by dividing the full volume of the septic tank by the daily wastewater discharge from the house, becomes shorter, with time of the septic tank operation, when the accumulated sludge occupies more and more septic tank space. It seems reasonable to assume that longer detention time must contribute to better decomposition of the organic matter into simpler forms which are eventually removed from the septic tank, either in a liquid form with the septic tank effluent or in a form of gases such as hydrogen sulfide (H_2S), ammonia (NH_3), carbon dioxide (CO_2) and methane (CH_4). In fact, as a result of a higher degree of decomposition of the solids, the amount of sludge settled to the bottom of the septic tank was found to be smaller and the consistency of the sludge more uniform.

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1) The volume of the second compartment of a septic tank is usually about 50% of the volume of the first one.

As can be observed from Table 1, the highest total sludge accumulation rate (0.29 l/p.d.) was observed in the Whitby septic tank where the detention time was the shortest (1.9 days). The sewage in that tank was not completely decomposed and small pieces of food, toilet paper, rags, etc. were observed in the sludge. Some amounts of grit and silt entered, probably the Whitby tank with the run-off water.

In the Hawkestone septic tank, where the detention time was the longest (∿9.7 days), the sludge accumulation rate was about 62% of that in the Whitby tank and about 80% of the accumulation rate in the Orillia tank. The lower sludge accumulation rate observed in the Hawkestone tank took place despite the fact that the raw sewage treated in that tank was stronger than in the two other tanks. The sludge in the Hawkestone septic tank was of uniform consistency without any solid pieces. Higher sludge accumulation rates in a tank leads to shorter time intervals between septic tank cleanings (Table 1).

It was observed that the total volume of the sludge accumulated jointly in both of the compartments of the septic tanks during the periods of time between regular septic tank cleanings, amounted to about 50% (46.7 to 55.7%) of the total volume of the septage pumped out from the septic tank. (Table 1).

The determined sludge accumulation rates in the Hawkestone, Orillia and Whitby septic tanks were: 0.18, 0.22 and 0.29 litres per person per day (l/p.d.) respectively. The accumulation rate (0.22 l/p.d.) observed in the Orillia septic tank, seems to be more typical for the Province of Ontario because of the kind of domestic wastewater treated, in that tank, because of the tight connection of the Orillia septic tank to the house and also because of the more typical length of the detention time (2.4 days), which

is close to that recommended by literature (5). It is of interest to note that the average sludge accumulation rate observed after the first year of operation of 205 septic tanks tested in the USA was 0.19 l/p.d.(6).

For sludge and septage disposal or treatment planning purposes, the Orillia per person sludge contribution rate, increased by 25% (0.22 x 1.25 = 0.28 l/p.d.), can be considered applicable. The septage contribution rate is about twice as much i.e. about 0.56 l/p.d. or 200 l/p year. For similar planning purposes in the USA, individual state regulations allow the use of fixed per capita septage contributions, equivalent to 190 to 1380 l/person year (7).

Assuming that 2.5 million residents of Ontario use private sewage disposal systems, the total amount of septage pumped out and disposed of annually, is about $200 \times 2.5 \times 10^6 = 500 \times 10^6$ litres.

The Life Sciences and Agriculture Experiment Station at the University of Maine, Orono (USA) determined that the rates of application of septage to surface of the land, without causing pollution of the surface or ground waters, should vary from 58.53 l/m^2. year on well drained soils to 34.65 l/m^2. year on moderately well drained soils (7).

The land required for the Province of Ontario for domestic septage disposal, assuming the poorer category of soil is used, would be about 14 km^2.

3.2 Time Intervals Between Septic Tank Cleanings

The permissible time intervals between cleanings of the three septic tanks studied are shown in Table 1. A period of about 8 years was the permissible time for the big, nontypical, Hawkestone septic tank and about 1.5 years for the relatively small Whitby septic tank. The time intervals show a positive relation to the detention times which are equal to the ratio between the volume of the tank and the daily wastewater discharge.

The expected time intervals between cleanings for septic tanks designed in accordance with the Ontario septic tank recommendations (1) are presented in Table 2. It was assumed that the average sludge accumulation rate in the first compartment of the septic tanks is 0.17 l/p.d. as determined from the Orillia septic tank operation.

The determined time intervals between cleanings of the septic tanks designed according to regulations are between 2.7 years for bigger tanks (serving 10 residents) and 3.8 years for more typical septic tanks serving a four resident house.

3.3 Determination of Contaminant Concentration in Septage

It follows from the 1 to 1 sludge to supernatant volume relations in a septic tank, at the time of regular tank cleaning, that the concentration of a given contaminant in the septage is roughly equal to the arithmetic mean of the appropriate concentrations of the contaminant in the sludge and in the supernatant of which the septage is a mixture. However, as the concentrations of the contaminants in the sewage fractions of the second compartments of the septic tanks are usually lower than in the first ones (Tables 3 and 4), the concentrations were calculated in this study, as weighted averages of the respective concentrations in the sludge and supernatant of both compartments of the septic tanks.

If the concentrations of a given contaminant in the sludge and in the supernatant taken from both compartments are C_1, C_2, C_3, and C_4 and the respective volumes of the sludge and supernatant, at the time of regular septic tank cleanings, are V_1, V_2, V_3, and V_4 (Table 1), the weighted average concentrations "C" of a given contaminant in the septage is:

$$C = \frac{C_1V_1 + C_2V_2 + C_3V_3 + C_4V_4}{V_1 + V_2 + V_3 + V_4}$$

where the sum of the volumes shown in the denominator of the formula is

TABLE 2

EXPECTED TIME INTERVALS BETWEEN
SEPTIC TANK CLEANINGS[1)]

Number of persons		p	4	6	8	10	12
Volume of Septic Tank	I comp.(66.6%)	l	1510	1820	2270	2730	3270
	II comp. (33.4%)	l	760	910	1140	1360	1640
	Total (100%)	l	2270	2730	3410	4090	4910
		Imp. gal.	(500)	(600)	(750)	(900)	(1080)
Depth of Liquid in Septic Tank		cm	122	122	122	122	137
Permissible depth of Sludge in I compartment[2)]		cm	76	76	76	76	91
Permissible Volume of Sludge in I compartment		l	940	1130	1410	1700	2170
Expected Time Intervals Between Septic Tank Cleanings (years)		y	3.8	3.0	2.8	2.7	2.9

1) Septic tank capacities are in accordance with Ontario Septic Tank Regulations (1)
A 0.17 l/p.d. accumulation rate of sludge in the first compartment was used in the calculations.

2) Permissible highest level of sludge is 46 cm below the level of liquid in septic tank (1).

equal to the total volume of the septage pumped out when cleaning the tank. Table 5 presents the average concentrations of some contaminants in the septage calculated in accordance with the above formula.

3.4 Chemical and Bacteriological Characteristics of Sludge and Septage

Two main factors determine the characteristics of the sludge and septage in the septic tanks:

a. the strength of the raw wastewater entering the tank (e.g. toilet wastewater only, toilet wastewater diluted in total household wastewater etc).

b. the detention time of the sewage in the septic tank (i.e. the relation of the total volume of the septic tank to the daily volume of wastewater treated).

The concentrations of contaminants in the supernatant, sludge and septage of the three septic tanks investigated are shown in Tables 3, 4 and 5. The effects of factors a and b (above) are more visible when comparing the chemical and bacteriological characteristics of the sewage fractions of the Hawkestone and Whitby septic tanks in which wastewaters of different strength were treated and the detention times were different (Table 1).

In the Hawkestone septic tank only toilet wastewater, undiluted in other household wastewaters, was treated. The capacity of the tank was sufficient for detention of the wastewater discharged into the tank, for about 10 days. The wastewater entering the Whitby septic tank contained toilet wastewater diluted in bathroom, kitchen and laundry wastewaters and the capacity of the tank enabled only a 1.9 day detention period. The Orillia septic tank capacity enabled a 2.4 day detention time i.e. the average time (2 to 3 days) recommended by Literature (5) and by Septic Tank Regulations (1).

TABLE 3

CONCENTRATION OF CONTAMINANTS IN SEPTIC TANK SUPERNATANT (AVERAGE DATA)[1)]

	Concentration of Contaminants					
Location of Septic Tank	Hawkestone Farm		Orillia Hospital House		Whitby Experim. Station	
Septic Tank Compartment	I	II	I	II	I	II
Total Phosphorus	24.0	19.2	17.0	15.0	10.0	2.4
Soluble Phosphorus	3.6	15.8	12.0	12.0	5.3	1.4
Total Solids	1100	630	1695	840	1700	665
Suspended Solids	400	80	760	65	147	30
BOD_5	260	74	300	160	110	34
TOC	N.T.[2)]	N.T.	555	250	65	18
COD	N.T.	N.T.	1424	448	315	75
pH	7.7	7.7	7.3	7.2	7.2	7.4
Ammonia (as N)	160	141	56	68	8.7	10.3
Total Kjeldahl (as N)	210	153	85	75	18.7	14.7
Nitrite (as N)	0.01	0.01	0.03	0.02	0.04	0.39
Nitrate (as N)	0.44	<0.1	<0.1	0.1	0.17	0.23
Chlorides (as Cl)	100	100	165	98	94	96
Sulphates (as SO_4)	50	41	41	40	76	80
Aluminium (as Al)	4.0	0.17	0.6	0.14	0.82	0.14
Iron (as Fe)	3.9	1.0	1.3	0.6	0.83	0.80
Calcium (as Ca)	60	50	61	55	106	111
Magnesium (as Mg)	7.0	5.0	24	33	15	15
Sodium (as Na)	71	60	93	76	45	46
Potassium (as K)	41	41	20	24	5	5
Hardness (as $CaCO_3$)	88	88	252	274	358	370
Alcalinity (as $CaCO_3$)	680	673	534	539	260	257
El. conductivity μmho/cm)	1700	1775	1240	1380	922	956
Total coliform org/100 ml	0.46×10^6	0.38×10^6	3.3×10^6	2.6×10^6	3.0×10^6	8.1×10^6
Fecal coliform org/100 ml	0.41×10^6	0.14×10^6	1.9×10^6	1.08×10^6	0.65×10^6	0.36×10^6

1. All data except of pH, el conductivity and coliform organisms given in mg/l

2. N.T. - not tested

TABLE 4

CONCENTRATION OF CONTAMINANTS IN SEPTIC TANK SLUDGE (AVERAGE DATA)[1)]

	Concentration of Contaminants					
Location of Septic Tank	Hawkestone Farm		Orillia Hospital House		Whitby Experim. Station	
Compartment of Septic Tank	I	II	I	II	I	II
Total Phosphorus	610	18	170	160	200	135
Soluble Phosphorus	1.7	2.8	33.0	19.0	23.5	6.1
Total Solids	23,350	620	33,550	28,495	35,400	27,070
BOD_5	6,000	380	13,500	15,000	12,000	4,900
TOC	N.T.[2)]	100	N.T.	10,400	3,525	2,545
COD	N.T.	N.T.	35,600	44,200	20,000	17,050
pH	N.T.	8.4	6.8		6.2	6.8
Ammonia (as N)	19	22	88	92	47	26
Total Kjeldahl (as N)	2,200	170	630	650	900	298
Nitrite (as N)	0.01	0.01	0.02	0.05	0.1	0.02
Nitrate (as N)	0.98	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorides (as Cl)	50	57	78	83	156	139
Sulfates (as SO_4)	28	19	21	17	33	51
Aluminium (as Al)	5.3	0.29	14	4	10	7.9
Iron (as Fe)	160	0.75	50	70	380	158
Calcium (as Ca)	66	22	56	82	132	153
Magnesium (as Mg)	10	6	41	36	34	8
Sodium (as Na)	55	53	89	82	64	61
Potassium (as K)	22	20	26	28	16	10
Hardness (as $CaCO_3$)	N.T.	N.T.	308	352	470	432
Alcalinity (as Ca CO_3)	N.T.	N.T.	2,070	2,660	704	1,254
El. conductivity (μmho/cm)	N.T.	N.T.	1,600	1,650	N.T.	1,750
Total coliform org/100 ml	0.9×10^6	0.42×10^6	16×10^6	1.6×10^6	99.0×10^6	16.0×10^6
Fecal coliform org/100 ml	0.9×10^6	0.11×10^6	6.9×10^6	0.58×10^6	7.8×10^6	0.6×10^6

1. All data, except of pH, el. conductivity and coliform organisms are given in mg/l.

2. N.T. - not tested.

TABLE 5

CONCENTRATION OF CONTAMINANTS IN SEPTIC TANK SEPTAGE (AVERAGE DATA)[1)]

	Concentration of Contaminants		
Location of Septic Tank	Hawkestone Farm	Orillia Hospital House	Whitby Experim. Station
Total Phosphorus	281	100	96
Soluble Phosphorus	6	22	13
Total Solids	10,780	18,610	17,136
BOD_5	2,747	7,810	5,496
TOC	N.T.[2)]	N.T.	1,660
COD	N.T.	21,450	9,490
pH	7.0 - 8.7	6.8 - 7.3	6.2 - 7.4
Ammonia (as N)	89	77	27
Total Kjeldahl (as N)	1,072	390	416
Nitrite (as N)	0.01	0.03	0.16
Nitrate (as N)	0.58	0.10	0.15
Chlorides (as Cl)	77	103	122
Sulfates (as SO_4)	37	29	57
Aluminium (as Al)	3.5	6.7	4.9
Iron (as Fe)	72	31	173
Calcium (as Ca)	59	60	120
Magnesium (as Mg)	8	35	23
Sodium (as Na)	61	86	54
Potassium (as K)	32	24	10
Hardness (as $CaCO_3$)	N.T.	293	413
Alcalinity (as $CaCO_3$)	N.T.	1,465	488
Total coliform org/100 ml	0.63×10^6	8.4×10^6	47×10^6
Fecal coliform org/100 ml	0.55×10^6	3.7×10^6	3.7×10^6

1. All data except of pH, and coliform organisms are given in mg/l

2. N.T. - not tested

The concentration of total phosphorus and total Kjeldahl nitrogen in the septage of the Whitby septic tank were about three times lower than the concentrations of the same chemicals in the septage of the Hawkestone tank. (Table 5) In the supernatant of the second compartment of the Whitby septic tank, the concentrations of these chemicals were respectively about 8 and 10 times lower than in the second compartment of the Hawkestone tank. (Table 3) The main reason of the lower concentrations of the above chemicals in the Whitby supernatant and septage is the higher dilution of the Whitby toilet wastewater with other household wastewater. The concentrations of the above contaminants in the septage from the Orillia septic tank were almost the same as in the Whitby tank septage because of similar kinds of raw sewage treated and because of the similar detention times.

The concentrations of the total solids in the septage of the Hawkestone, Orillia and Whitby septic tanks were: 10,780 mg/1, 18,610 mg/1 and 17,136 mg/1 respectively. It seems reasonable to assume that the low total solids concentration observed in the Hawkestone septic tank was caused by the relatively long detention time (10 days) during which a better decomposition of the organic matter was achieved. Again the average concentrations of the total solids in the septage of Orillia and Whitby septic tanks were very close. The 1.86% concentration of solids in the septage of the Orillia septic tank is close to the 2.0% concentration of solids in septage reported by Kolega and Dewey (8) from Connecticut studies.

The concentrations of the BOD_5, Sulfates (SO_4) and total and fecal coliform organisms in the septage of the Hawkestone septic tank (Table 5) were also lower than in the Whitby septic tank. The fecal

coliform organisms concentrations in the Orillia and Whitby septage are equal; the reason for much higher total coliform concentrations in the Whitby septic tank septage is not clear.

For septic tank sludge and septage treatment and disposal considerations, the chemical and bacteriological characteristics of the Orillia septic tank sludge and septage seems to be more typical (Tables 4 and 5).

3.5 Balance of Salt in the Septic Tank Contents

The Hawkestone septic tank was used for toilet wastewater treatment only and thus the sodium chloride (NaCl) entering the tank could come only from the food consumed by the residents. Calculations using the determined flow rate of the wastewater, the sludge accumulation rate given in Table 1 and the average concentrations of the sodium and chlorides in the supernatant and sludge given in Tables 3 and 4, show that the combined amount of sodium and chlorides discharged into the tank total 18.8 grams per person per day (g/p.d.). According to Baron (9) the typical daily salt (NaCl) balance of a normal adult is about 12.5 g/p.d.

Similar salt balances calculated for the other two tanks studied show 29.3 g/p.d. for the Orillia tank and 23.9 g/p.d. for the Whitby tank. The higher discharge of sodium chloride observed in those two tanks could be caused by the use of synthetic detergents most of which are built up by the addition of such neutral salts as sodium or calcium chloride to increase detergency properties (10).

3.6 Inorganic and Organic Content of Sludge

Inorganics

The inorganic components of the sludge are affected partially by the characteristics of the water supply to the houses and by the sludge uptake of inorganic contaminants. Table 6 shows some inorganic constituents in the septic tank sludge as compared with the appropriate constituents

in digested and activated sewage sludge from municipal treatment plants (11). No data for inorganics in septic tank sludges were found in the literature.

TABLE 6

SOME INORGANIC CONSTITUENTS IN SEPTIC TANK SLUDGE[1)]

(% OF DRY WEIGHT)

Chemical Constituents	Septic Tanks			Municipal Sludge (11)	
	Hawkestone	Orillia	Whitby	Digested	Activiated
Chlorides (as Cl)	0.23	0.25	0.44	-	0.50
Aluminium (as Al)	0.02	0.04	0.03	3.6	1.70
Iron (as Fe)	0.68	0.17	1.05	3.8	5.00
Calcium (as Ca)	0.29	0.19	0.38	4.8	1.20
Magnesium (as Mg)	0.04	0.12	0.09	1.1	1.10
Sodium (as Na)	0.25	0.27	0.18	-	0.72
Potassium (as K)	0.10	0.08	0.04	0.36	0.72
Phosphorus (as P)	2.61	0.52	0.56	0.88	1.36

The higher concentrations of inorganics observed in the sludges of the municipal sewage treatment plants could be caused by the metals and other chemicals entering the plants with the industrial wastewaters.

Organics

The organic content of a sludge is expressed in the most rational way in terms of Chemical Oxygen Demand (COD) or Total Organic Carbon (TOC) per dry unit weight of sludge. Table 7 shows the above relations in the sludges investigated.

TABLE 7

AMOUNT OF COD AND TOC PER DRY UNIT WEIGHT OF SLUDGE

(in kg per kg of dry sludge)

Organic Content	Hawkestone Tank		Orillia Tank		Whitby Tank	
	I comp.	II comp.	I comp.	II comp.	I comp.	II comp.
COD	N.T.[2)]	N.T.	1.06	1.55	0.57	0.63
TOC	N.T.	0.16	N.T.	0.37	0.10	0.09

1) The concentration values of the components in the septic tank sludge are weighted averages of the concentrations in both of the compartments of the septic tanks.

2) N.T. - not tested

The organic content in the sludge from the Orillia septic tank is about 2 to 3 times higher than in the sludge of the Whitby septic tank which could contain inorganic grit and silt from infiltration. The COD and TOC in the Hawkestone septic tank sludge were not tested.

It was also of interest to compare the septage characteristics determined in this study with the characteristics of domestic septage reported in literature.

TABLE 8

CONCENTRATION OF SOME CONTAMINANTS IN DOMESTIC SEPTAGE AS COMPARED WITH LITERATURE DATA (values in mg/l execpt pH)

Contaminant	This Study	New England Guidelines for Septage Disposal (7)
Total Phosphorus (as P)	96 - 281	150 - 275
Total Solids	10,780-18,610	13,782-130,475
BOD_5	2,747- 7,810	2,083-6,100
COD	9,490-21,450	24,700-57,000
Ammonia	27 - 89	72 - 150
pH	6.2 - 8.7	4.2 - 9.0

The extended range of the contaminant concentrations in septage is a result of variable factors some of which, like the strength of the raw sewage or the detention time in the septic tanks, were discussed above.

4. Conclusions

1. The sludge and supernatant samples taken from the septic tank, by using a transparent tube sampler, appeared to be representative of the quality and quantity of the septic tank contents.

2. The chemical and bacteriological properties of the sludge and septage depend mainly on the strength of the raw sewage and on the detention time of the sewage in the tank. Longer detention times contribute to better decomposition of organic materials and consequently to lower accumulation

rates of sludge and to smaller average amounts of septage pumped out per year.

3. The volume of the septage pumped out from a septic tank, at the time the sludge in the tank reaches a permissible level, is about twice the volume of the sludge accumulated in both of the septic tank compartments.

4. The determined septage accumulation rate, which is applicable for septage disposal and treatment planning is approximately 200 litres per person per year. ($\sim$44 x 10^6 Imp. gal/person/yr).

5. The volume of domestic septage generated per year by the 2.5 million residents of Ontario living in areas beyond reach of public sewers, is about 500 x 10^6 litres. ($\sim$110 x 10^6 Imp. gal). The land required for the septage disposal in Ontario is about 14 km^2. ($\sim$3500 acres).

6. The determined time intervals between cleanings of septic tanks designed in accordance with the Ontario septic tank regulations are between 2.7 years for 4000 litre ($\sim$900 Imp. gal.) tanks and 3.8 years for 2300 litre ($\sim$500 Imp. gal) tanks.

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